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Distribution extensions for species of the *Passiflora* subgenus *Astrophea* (DC.) Masters from Brazil (Passifloraceae s.s.)

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Abstract

New records for species of *Passiflora* subgenus *Astrophea* are reported, contributing to the increasing distribution knowledge of the Passifloraceae in Brazil. These records are: *Passiflora balbis* Feuillet, from the state of Amazonas, *Passiflora ceratocarpa* F. Silveira, from the states of Amapá and Amazonas, *Passiflora cerradensis* Sacco, from Minas Gerais, *Passiflora costata* Mast., from Acre, Amapá, Mato Grosso, and Roraima, and *Passiflora mansoi* (Mart.) Mast., from Maranhão and Tocantins.

Key words

Amazon Rainforest; Cerrado; distribution; new records; range extension; Passifloraceae.

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Introduction

Passifloraceae s.s. contains 17 genera and has a Pantropical distribution (Feuillet and MacDougal 2007). The genus *Passiflora* Linnaeus (1753: 955) is the most representative genus with 525 species (Ulmer and MacDougal 2004). Most of these species occur in the Americas, with only 20 species occurring in India, China, Southeast Asia, Australia, and the islands of Oceania (Bernacci et al. 2003). Species of *Passiflora* are divided into 5 subgenera: *Passiflora* subg. *Astrophea* (De Candolle 1822: 338) Masters (1871: 629), *P.* subg. *Deidamioides* (Harms 1923: 59) Killip (1938: 25), *P.* subg. *Decaloba* (De Candolle 1822: 435) Reichenbach (1828: 132), *P.* subg. *Passiflora*, and *P.* subg. *Tetrapathea* (De Candolle 1822: 435) Green (1972: 553) (Feuillet and MacDougal 2003, Krosnick et al. 2009).

Passiflora subg. *Astrophea* contains approximately 60 species distributed throughout Central and South America (Ulmer and MacDougal 2004). Feuillet and MacDougal (2003) divided *P.* subg. *Astrophea* into 2 supersections: *A.* supersect. *Astrophea*, with 3 sections and the *A.* supersect. *Pseudoastrophea* (Harms) Feuillet & MacDougal (2003: 35), with 2 sections.

About 25 species of the *P.* subg. *Astrophea* occur in Brazil (Flora do Brasil 2017), including a newly described species, *Passiflora lorenziana* Mezzonato & Bernacci, for the group (Mezzonato-Pires et al. 2016). Although the species of *P.* subg. *Astrophea* are poorly known, they

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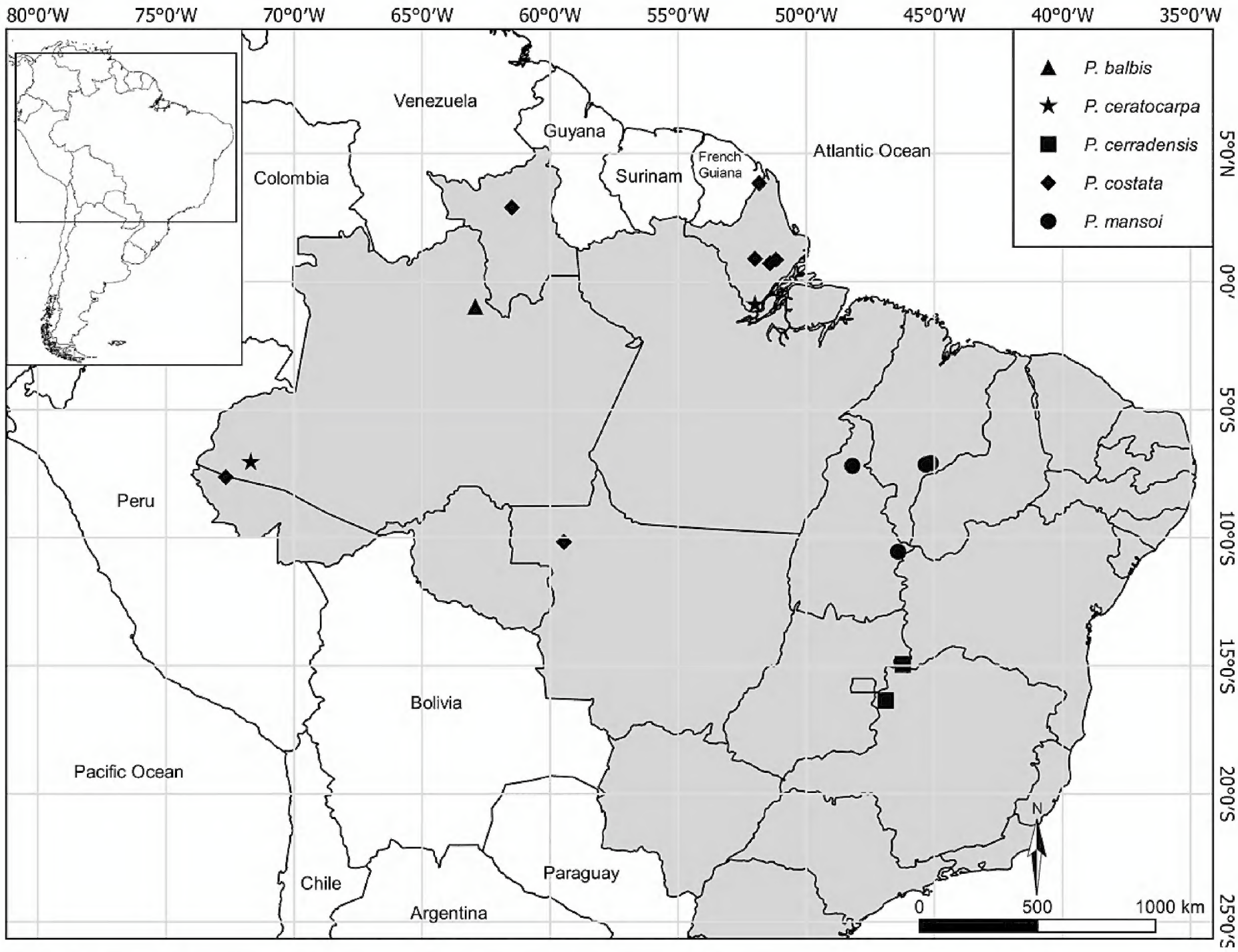

Figure 1. Distribution map of new occurrences of species of *P.* subg. *Astrophea* for Brazil.

are found in all regions of Brazil, but predominantly in the North Region.

The species of *P.* subg. *Astrophea* are similar to the species of *P.* subg. *Passiflora*, but possess unique morphological characteristics that make them one of the most different categories within the genus. In addition to being woody lianas, they may also be arborescent plants lacking the tendrils. They possess inconspicuous stipules, pinnate leaf venation, petioles with 2 nectaries near the base of the leaves, and tubulose flowers (Ulmer and MacDougal 2004).

The present work is a result of an ongoing taxonomic revision of the *P.* subg. *Astrophea* in Brazil, and provides descriptions, illustrations, and distribution maps of the new records of these species of *Passiflora* in Brazil.

Methods

The herbaria consulted were CEN, HAMAB, HUEFS, IAN, INPA, MG, NYBG, RB, SP, UB, UEC, and UPCB (acronyms are in accordance with Thiers 2017). The terminological concepts used for the descriptions are in agreement with Radford et al. (1974), Feuillet and MacDougal (2003), and Mezzonato-Pires (2017). A distribution map was built using the software Quantum GIS 2.17. A stereoscopic microscope was used for the illustrations. The geographic coordinates data enclosed in brackets indicated that they are approximate (derived by the authors) in relation to the original point.

Results

The previously known geographic distribution of 5 species belonging to *P.* subg. *Astrophea* are extended: *Passiflora balbis* Feuillet (2002:20) is recorded for the first time from the state of Amazonas; *Passiflora ceratocarpa* Fernando Silveira (1930: 370) from the states of Amapá and Amazonas; *Passiflora cerradensis* Sacco (1971: 212, 213) from Minas Gerais; *Passiflora costata* Masters (1872: 573) from Acre, Amapá, Mato Grosso, and Roraima; and *Passiflora mansoi* (Martius: 1839: 7) Masters (1871:629) from Maranhão and Tocantins (Fig. 1).

Passiflora balbis Feuillet, Brittonia 54(1): 20, fig. 2. 2002. Figure 2A.

Lianas; tendrils thin, spines absent. Branches robust, cylindrical, striated, glabrous. Stipules not seen. Petioles 1.8–6.0 cm long, glabrous, slightly flattened; 2 prominent, elliptical glands on adaxial surface at the apex of the petiole. Leaf blades 9.0–14.5 × 5.6–9.4 cm, ovate-lanceolate to ovate, chartaceous; apex acute, acute-macronate or obtuse-acuminate; base slightly chordate, chordate or rounded; glabrous on both surfaces. Peduncles 0.2–1.5 cm long. Bracts 0.03–0.1 × 0.03–0.05 cm, triangular,

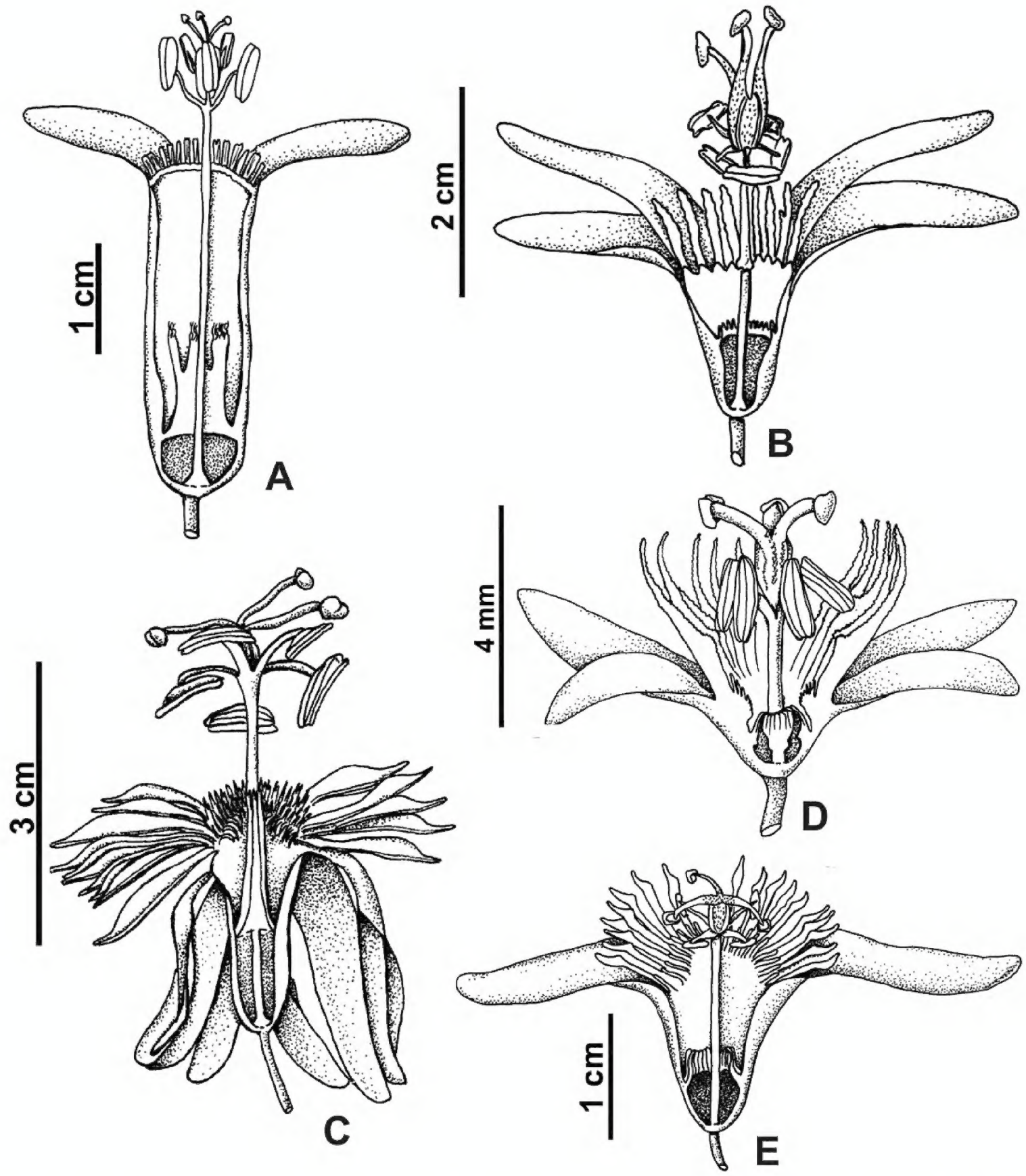

Figure 2. Longitudinal cut of the flowers of *P.* subg. *Astrophea*. **A.** *Passiflora balbis* Feuillet (G.T. Prance et al. 28721 INPA). **B.** *Passiflora ceratocarpa* F.Silveira (B.G.S. Ribeiro 1129 IAN). **C.** *Passiflora cerradensis* Sacco (A.Salino 5730 BHCB). **D.** *Passiflora costata* Mast. (J. Pruski et al. 3348 HAMAB). **E.** *Passiflora mansoi* (Mart.) Mast. (T.B. Cavalcanti et al. 3029 CEN). Illustrations by Monique Goes.

alternate. Pedicels 0.01–0.15 cm long. Flowers pink, inflorescence racemous, cauliflorous, hypanthium cylindrical, 1.4–4.7 cm long, 0.4–0.6 cm in diameter; sepals 0.9–1.6 × 0.3–0.6 cm, oblong-lanceolate; petals 0.8–1.3 × 0.2–0.5 cm, lanceolate-triangular; corona comprises 2 series of filaments, external series 0.1–0.2 cm long, liguliform, internal series 0.01–0.04 cm long, filaments continuous, crests or tubercles; operculum 0.3–1.0 cm long, erect, fimbriate in the upper third, filamentous; androgynophore 1.5–5.1 cm long, trochlea absent; ovary 0.4–0.5 × 0.1–0.25 cm, obovate, ovate-elliptical to closely elliptical, glabrous. Fruit 1.6–3.7 × 0.7–2.0 cm, ovoid to ellipsoid, glabrous.

Material examined. Brazil. Amazonas: Barcelos, Vicinity of Pico Rondon, perimetral Norte highway, 3 km from km 211, lower slopes of Pico Rondon [00°58′29″ S, 062°55′27″ E], 02/II/1984, fl. e fr., G.T. Prance et al. 28721 (INPA, MG, NYBG, UB, UPCB).

Passiflora balbis belongs to *P.* series *Carneae*, being the only species presented here that possesses pink flowers and a cylindrical hypanthium, which easily distinguishes the species from other taxa.

The species occurs in Brazil, Guyana and Venezuela (Tropicos 2017). In Brazil, it has previously been recorded from the state of Roraima, and now is newly recorded from the state of Amazonas. It is most commonly found in seasonally flooded forests at elevations of 75–1650 m (Feuillet 2002), but in Brazil they are found in *terra firme* forests, savannas, on the banks of "capoeiras", and among granite outcrops, at 107 m elevation.

Passiflora ceratocarpa F. Silveira, Arch. Jard. Bot. Rio de Janeiro 5: 221, pl. 30. 1930.
Figure 2B.

Lianas or arborescent lianas, tendrils robust, spines absent. Branches subangular or cylindrical, striated, villous or densely puberulous. Stipules not seen. Petioles

0.8–1.3 cm long, velutinous to tomentose; 2elliptical or triangular glands on abaxial surface, lateral to junction of leaf blade and petiole. Leaf blades 5.0–17.4 × 4.6–14.8 cm, ovate, broadly ovate, membranaceous in young leaves and slightly coriaceous in mature leaves, apex emarginate, obtuse or acute, base chordate, adaxial surface pilose and abaxial surface velutinous. Peduncles 0.2–0.6 cm long. Bracts 0.04 × 0.06 cm, linear-lanceolate or triangular, alternate. Pedicels 0.7–0.8 cm long. Flowers solitary or in pairs, hypanthium cylindrical-campanulate, 0.5–0.8 cm long, 0.2–0.3 cm in diameter; sepals 1.5–1.9 × 0.4–0.5 cm, obovate-lanceolate, linear-oblong; petals 1.7–1.9 × 0.2–0.3 cm, linear-oblong; corona comprises 2 series of filaments, external series 0.5–0.7 cm long, linear-falcate, internal series 0.01–0.06 cm long, triangular or linear-triangular; operculum 0.1–0.5 cm long, erect, filamentous, apex fimbriate, papillose; androgynophore 1.9–2.0 cm long, trochlea discoid present; ovary 0.3–0.5 × 0.2–0.4 cm, oblong, velutinous, densely velutinous. Fruit 3.3–3.6 × 2.6–2.7 cm, obovate, puberulous.

Material examined. Brazil. Amapá: Serra do Navio [00°53′44″ S, 052°00′08″ E],18/III/1962, fr., J. Mattos and N. Mattos 10148 (NYBG, SP, UPCB). Amazonas: next to Ipixuna, road Belém-Brasília [07°03′02″S, 071°41′41″ E], 20/IX/1975, bt., B.G.S. Ribeiro 1129 (IAN).

Passiflora ceratocarpa belongs to *P.* sect. *Pseudoastrophea*. It is similar to *P. mansoi* due to the shape of the leaf blades and the location of the petiole glands on the abaxial surface. However, *P. ceratocarpa* is easily distinguished by the linear-falcate shape of its external filaments, which possess undulate-verrucose margins, and smaller internal filaments, which are triangular or linear-triangular in shape.

The species occurs in Guyana, French Guiana, and Brazil (Tropicos 2017), but in Brazil the species had previously only been recorded in the state of Pará, the state of the type locality. However, the present study has identified specimens of this species from the state of Amapá, municipality of Serra do Navio, and the state of Amazonas, near Ipixuna. They were found in *terra firme* forest, along forest edges and "capoeiras", in secondary forest, on sandy soils.

Passiflora cerradensis Sacco, Proceedings of the 3rd Symposium on the Cerrado (Anais 3° Simpósio sobre o Cerrado), São Paulo: E. Blucher/EDUSP, Embrapa Cerrados (CPAC), 212, 1971, "cerradense".
Figures 2C, 3A, 3B.

Lianas; tendrils thin, spines absent. Branches cylindrical, striated, glabrous. Stipules 0.1 × 0.03–0.04 cm, narrowly linear-triangular, glabrous. Petioles 1.0–1.8 cm long, glabrous; 2obovate, elliptical glands on the adaxial surface, near the apex of the petiole. Leaf blades 7.0–17.3 × 3.3–7.3 cm, ovate, ovate-lanceolate or oblong-lanceolate, coriaceous, apex obtuse-mucronate, rarely emarginated, base chordate, slightly chordate, truncate or obtuse, both surfaces glabrous. Peduncles 0.4–2.4 cm long. Bracts 0.2–0.4 × 0.07–0.1 cm, triangular to linear-triangular, verticillate, margin serrate with glands. Pedicels 0.2–0.7 cm long. Flowers solitary or in pairs, hypanthium cylindrical, 8.8–22.1 mm long, 1.3–6.2 mm in diameter; sepals 2.3–2.7 × 0.4–0.8 cm, oblong-lanceolate; petals 2.1–2.3 × 0.4–0.7 cm, oblong-lanceolate; corona comprises 5–7 series of filaments, first series 1.0–1.1 cm de long, dolabriforme, second series 0.2–0.3 cm long, linear-spatulate, erect, third series 0.2–0.3 cm long, linear-capillary, erect; fourth series 0.2 cm long, linear-capillary, erect, fifth series ca 0.2 cm long, capillary, erect or reflexed towards hypanthium, sixth and seventh series 0.2–0.3 cm long, capillary, reflexed towards hypanthium; operculum 1.4–1.5 cm long, divided into 5 slits, erect, tubular, lacerated at apex; androgynophore 3.4–3.7 cm, trochlea absent; ovary 0.1–0.5 × 0.2 cm, elliptical, oblong or subglobose, velutinous. Fruits 4.2–4.3 × 2.5–2.7 cm, ellipsoid, puberulous, with persistent stylets.

Material examined. Brazil. Minas Gerais**:** Unaí, currency of Minas Gerais and Goiás, BR251 River Arrependido [16°21′27″ S, 046°54′22″ E], 29/II/1982, bt., P. Scheiner 57 (CEN); Formoso, Parque Nacional Grande Sertão Veredas, Cachoeira of stream Mato Grande, 15°19′07″ S, 45°59′07″ W, 18/X/1997, fl., M.A. Silva 3474 et al. (RB); Formoso, Rio Ponte Grande [14°56′48″ S, 046°13′55″ E], 29/IX/2000, fl., A. Salino 5730 (BHCB).

Passiflora cerradensis belongs to *P.* section *Capreolata*. It is distinguished by possessing a corona with 5–7 series of filaments, which are yellow at the base and orange with wine-colored speckles in the apical portion, and the inner filaments lilac.

The species is endemic to Brazil and occurs in the Distrito Federal (Federal District), and in the states of Goiás and Mato Grosso. We recorded a new occurrence for the state of Minas Gerais, municipality of Formoso (Parque Nacional Grande Sertão Veredas and Rio Ponte Grande) and in Minas Gerais and Goiás, along BR 251. They are found in the phytogeographic domains of Cerrado and Cerradão, where they occur in riparian forests with stony or sandy soils, but can also be found along trails, between 300 and 1079 m.

Passiflora costata Mast., Flora Brasiliensis 13 (1): 573. 1872.
Figs 2D, 3C, 3D.

Lianas; woody, tendrils robust, spines absent. Branches subcylindrical to cylindrical, striated, puberulous or pilose. Stipules 0.1 × 0.04–0.07 cm, linear-setaceous to linear-falcate, puberulous to pilos. Petioles 0.9–3.9 cm long, puberulous or pilose; 2 glands on abaxial surface, junction of leaf bald with petiole, in the main vein, ovate or elliptical. Leaf blades 6.7–20.5 × 4.0–13.7 cm, obovate, broadly obovate or oblong-ovate, chartaceous or coriaceous, apex emarginated, rounded or mucronate, base subpeltate, rounded, adaxial surface glabrous, abaxial surface puberulous or pilose; ca 18–36 glands along margin. Peduncles 0.8–1.3 cm long. Bracts 0.1–0.2

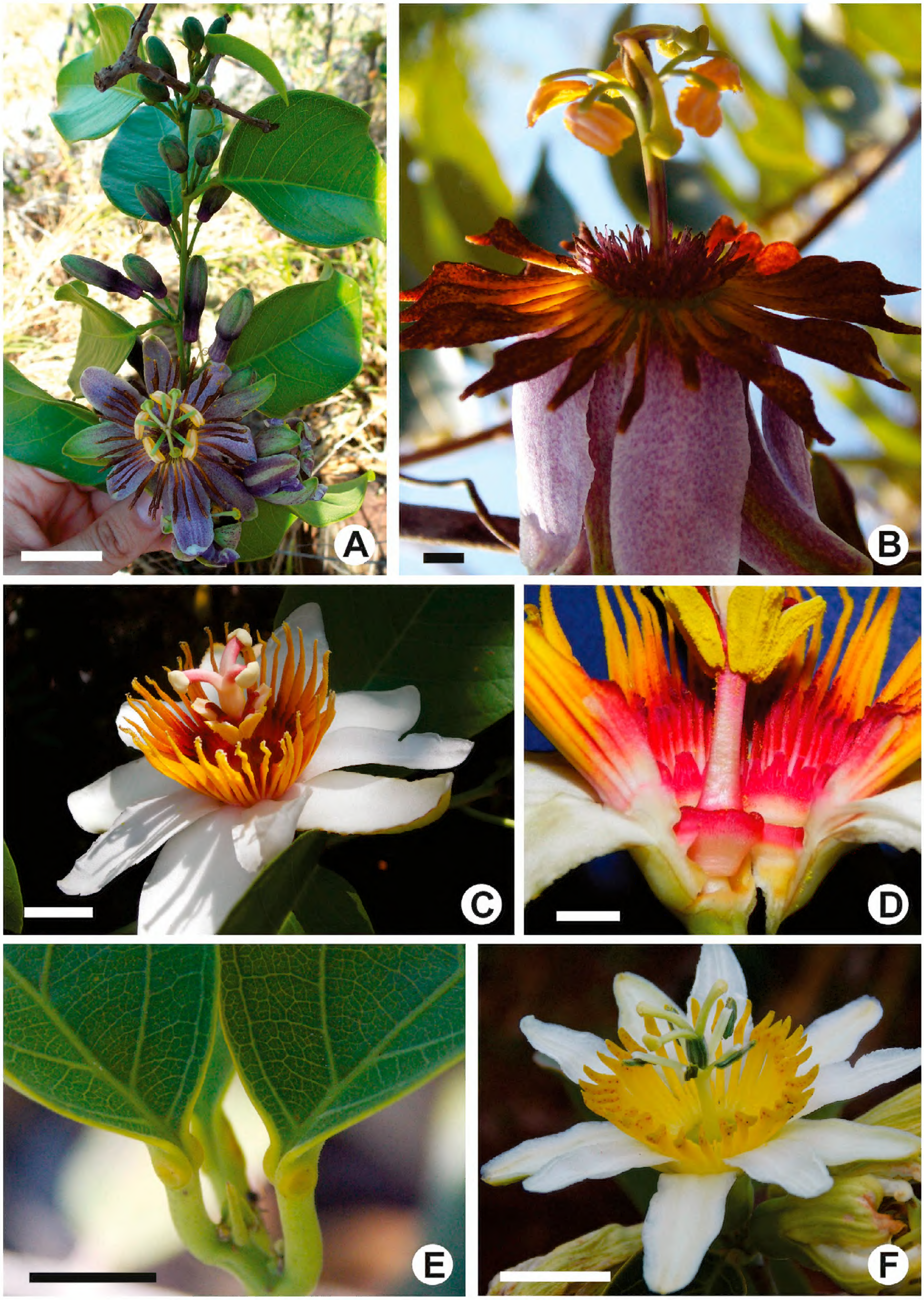

Figure 3. Photography species of *P.* subg. *Astrophea*. **A** and **B**: *Passiflora cerradensis* Sacco. **A.** Buds and flowers. **B**. Flower. **C** and **D**: *Passiflora costata* Mast. **C**. Flower. **D**. Longitudinal cut of the flower. **E** and **F**: *Passiflora mansoi* (Mart.) Mast. **E**. Detail of the petiole glands. **F**. Flower. Scale bars = 2 mm (B), 5mm (D), 10 mm (C, E, F), 20 mm (A).

× 0.04–0.07 cm, lanceolate-triangular, alternate. Pedicels 2.0–13.0 cm long. Flowers solitary, hypanthium broadly campanulate, 0.4–0.5 cm long, 0.7–1.2 cm in diameter; sepals 2.4–3.7 × 0.6–1.7 cm, linear-ovate; petals 2.4–3.1 × 0.6–1.6 cm, linear-oblong; corona comprises ca 8 series of filaments, first series 2.0–2.8 cm long, liguliform, second series 0.2–0.5 cm long, liguliform, third series 0.1 cm long, liguliform, other series 0.01–0.05 cm long, irregular, linear; operculum 0.2–0.3 cm long, reflexed, apex with minutely denticulate margin; androgynophore 2.0–2.2 cm, trochlea funiform present, ovary 0.5–0.9 × 0.2–0.5 cm, elliptical to obovate, velutinous or tomentose. Fruits 5.5–7.9 × 4.0–5.3 cm, ovoid, puberulous.

Material examined. Brazil. Acre: Cruzeiro do Sul [07°37′52″ S, 072°40′12″ E] , 21–28/VIII/1978, W. Benson 8317 (UEC). AMAPÁ: Parque Nacional Montanhas do Tumucumaque, Rio Mutum, rise of Rio [03°50′35″ N, 051°50′06″ E], 05/XI/2005, fl., A. Lobão and M. Cordeiro 1165 (IAN); Rio Araguari, along the river [00°42′48″ N, 051°24′48″ E], 13/IX/1961, fl., J.M. Pires, W. Rodrigues and G.C. Irvine 50904 (IAN); Rio Araguari, along the river, Porto Platon [00°42′48″ N, 051°24′48″ E], 18/IX/1961, fl., J.M. Pires, W. Rodrigues and G.C. Irvine 51056 (IAN); Rio Araguari, along the river, vicinity campo 12 [00°42′48″ N, 051°24′48″ E], 30/IX/1961, J.M. Pires, W. Rodrigues and G.C. Irvine 51347 (IAN); Rio Falsino, várzea [lowland] along the river, ca 10 km upstream to confluence with Rio Araguari, and about 8 hours up-river with boat to Porto Grande [00°51′30″ N, 051°10′48″ E], 02/X/1987, fl., J. Pruski et al. 3348 (HAMAB); Serra do Navio, Along the left bank of the Amapari River [00°53′44″ S, 052°00′08″ E], 23/XI/1954, fl., R.S. Cowan 38543 (RB). Mato Grosso: Rio Aripuanã, várzea [lowland] [10°10′ S, 059°27′34″ E], 17/I/1977, fr., M. Gomes and S. Miranda 499 (INPA). RORAIMA: Alto Alegre, Ilha of Maracá, SEMA Estação, Furo Paraná of Firmino of River Uraricuera on the south side of the island [02°53′45″ N, 061°29′51″ E], 14/VI/1986, fr., M.J.G. Hopkins et al. 748 (NYBG).

Passiflora costata belongs to the *P.* sect. *Pseudoastrophea*. It can be distinguished from other species by the abaxial position of the glands at the junction of the petiole with the blade in the main vein. In addition it has flowers with a widely-campanulate hypanthium and funiform trochlea positioned near the base.

The species has a broad distribution, with records in Guyana, French Guiana, Peru, Suriname, Venezuela, and Brazil (Tropicos 2017). In Brazil, it was initially found in the states of Amazonas, Maranhão, Pará, and Rondônia. However, based on material from national and international herbaria, new records for the states of Acre, Amapá, Mato Grosso, and Roraima were found. They occur in forests of igapó (backwater flooded forest) and várzea (seasonal floodplain forest), on islands, and along the banks of rivers, on clay soil and white sand.

A misidentified specimen in Koch et al. (2014) from Parque Nacional das Montanhas do Tumucumaque, collected by Lobão and Cordeiro 1165, previously identified and treated as *Passiflora candida* (Poepp. & Endl.), is *Passiflora costata.*

Passiflora mansoi (Mart.) Mast., Trans. Linn. Soc. London 27: 629. 1871. *Tacsonia mansoi* Mart., Flora 22 (1): 7. 1839.
Figures 2E, 3E, 3F.

Lianas; woody with thin to robust tendrils, or arborescent lianas without tendrils, spines absent. Branches cylindrical, striated, puberulous to hirsute. Stipules 0.05–0.1 × 0.02–0.03 cm, linear, puberulous. Petioles 0.6–1.4 cm long, velutinous, puberulouse, hirsute or glabrous; 2 glands on abaxial surface, laterally at the junction of the leaf blade with the petiole, oblong, triangular, obovate or ovate-elliptical. Leaf blades 3.5–18.5 × 2.8–12.5 cm, ovate, broadly ovate, ovate-lanceolate, elliptical or obovate, membranaceous to coriaceous, apex acute, retuse, mucronate or emarginated, base rounded and slightly chordate, obtuse or acute, abaxial surface velutinous or hirsute, adaxial surface pilose, silightly hirsute. Peduncles 0.2–1.0 cm long. Bracts 0.06–0.1 × 0.09 cm, triangular to deltate, alternate. Pedicels 0.5–1.6 cm long. Flowers solitary or in pairs, hypanthium cylindrical-campanulate or campanulate-funiliform, 0.6–1.3 cm long; 0.7–0.8 cm in diam.; sepals 1.5–2.5 × 0.3–0.6 cm, linear-oblong; petals 1.6–1.9 × 0.3–0.5 cm, linear-oblong; corona comprises 2series of filaments, external series 0.9–1.2 cm long, dolabriform, internal series 0.2–0.3 cm long, subulate or linear-capitelate; operculum 0.2–0.3 cm long, erect, filamentous, apex with fimbriate-subulate filaments, papilose; androgynophore 2.1–2.4 cm long, throclea absent; ovary 0.3–0.4 × 0.15–0.2 cm, obovate to oblong, velutinous to densely velutinous or hirsute. Fruits 2.5–4.4 × 2.0–3.6 cm, rounded to ellipsoid, vilous.

Material examined. Brazil. Maranhão: Loreto, Ilha de Balsas, between the Rios Balsas and Parnaíba 2/3 km south of main house of Fazenda “Morros”, about 35 km south of Loreto, “chapada Tucunzinho” [07°05′04″ S, 045°08′28″ E], 24/IV/1962, fr., G. Eiten and L.T. Eiten 43814 (UB); Sambaiba, road side BR230, 11 km from the border of the municipality towards São Raimundo das Mangabeiras [07°08′25″ S, 045°20′46″ E], 27/I/2012, fr., R.M. Harley et al. 56526 (HUEFS). Tocantins: Araguaína, ca of 2 km of Araguaína [07°11′28″ S, 048°12′26″ E], 18/III/1968, fr., H.S. Irwin et al. 21137 (UB); Mateiros, Parque Estadual do Jalapão, brejo da Forquilha, place of harvest of Capim Dourado [10°32′51″ S, 046°25′16″ E], 20/VI/2002, bt., fl. and fr., T.B. Cavalcanti et al. 3029 (CEN).

Passiflora mansoi belongs to the *P.* sect. *Pseudoastrophea*. It is distinguished from *P. ceratocarpa* by having dolabriform external filaments with attenuated-subulate apex, whole or slightly crenulated margin and linear-capitelate or subulate internal filaments. In addition, the apex of the operculum possesses subulate filaments.

The species is restricted to Brazil (BFG 2015), where

it has been known to occur in the states of Goiás, Mato Grosso, and Mato Grosso do Sul, and now with new occurrences for the states of Maranhão and Tocantins, in areas of cerrado and cerradões, along the borders of roads, on clay and sandy soil, and red latosol.

Discussion

These new records expand the known distributions of 5 species of *P.* subg. *Astrophea* indicating more areas requiring attention for the conservation of these species. Studies of Passifloraceae in Amazonia are scarce, with the most representative being Flora da Reserva Ducke (Hopkins and Souza 1999). Four new species were recently described for the Amazon (Vanderplank and Zappi 2011, Souza and Hopkins 2011, Koch et al. 2013, Mezzonato-Pires et al. 2016), only one of which belonged to the *P.* subg. *Astrophea*. Thus, although none of the new records of the present work deal with species completely new to science, they comprise occurrence records for species of a group that is poorly known in Brazil.

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Authors' Contributions

ACMP collected the data and wrote the text, CBFM, MAMA and VEG wrote and reviewed the text.

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